2010 Army Corrosion Summit

OSD Cost of Corrosion Study Methodology

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10 Feb 2010

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
10 FEB 2010		**00-00-2010 to 00-00-2010**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
OSD Cost of Corrosion Study Methodology	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **U.S. Army RDECOM,RDMR-WDP-A,Redstone Arsenal,AL,35898**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
2010 U.S. Army Corrosion Summit, Huntsville, AL, 9-11 Feb

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**23**	

Army Aviation and Missile Cost of Corrosion

Corrosion—
The deterioration of a material or its properties due to a reaction of that material with its chemical environment

DoD Cost of Corrosion

Results to Date

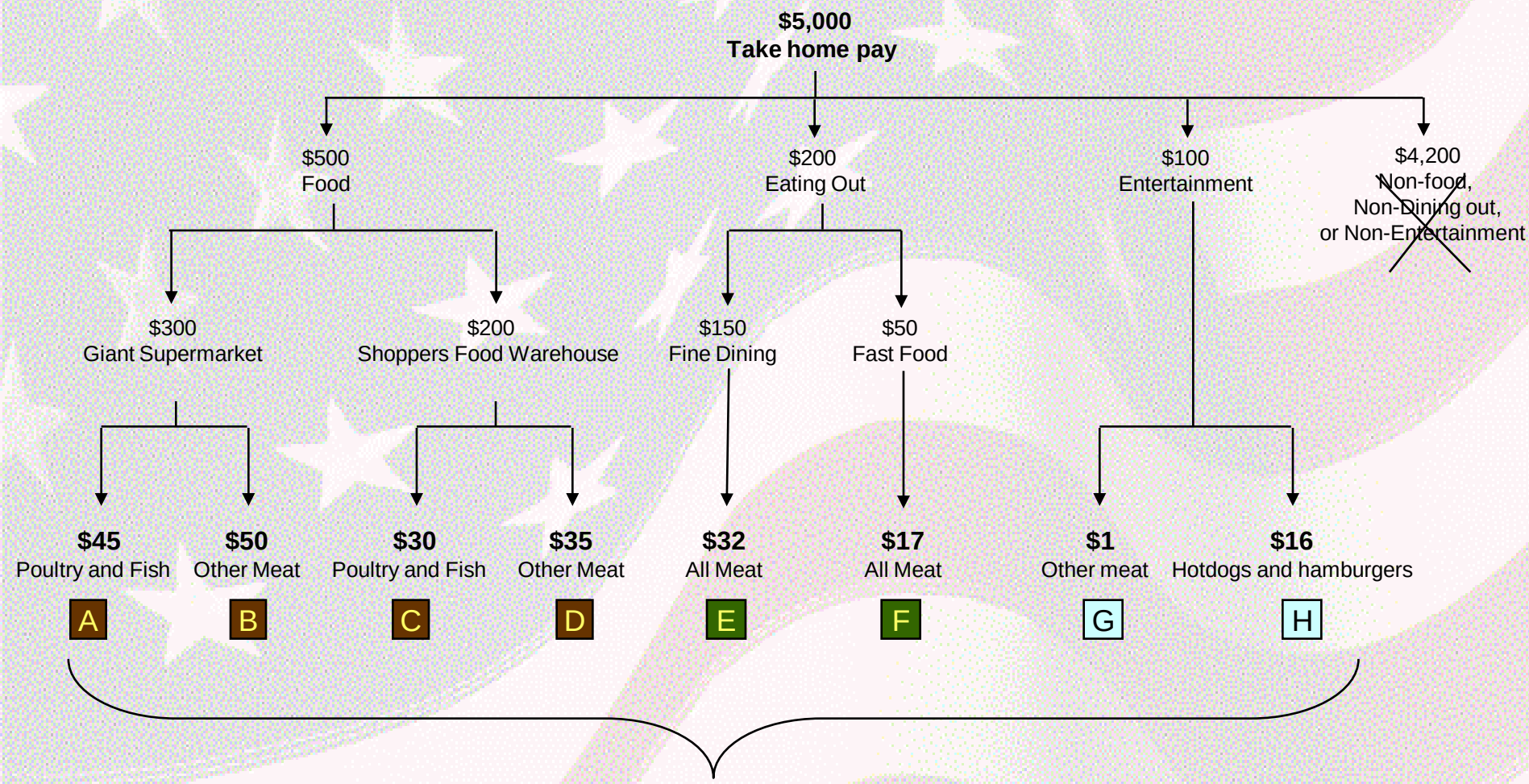
Study year baseline	Study segment	Annual cost of corrosion	Corrosion as a percentage of maintenance	Data
2005-2006	Army ground vehicles	$2.0 billion	14.8%	FY2004
	Navy ships	$2.4 billion	19.8%	FY2004
2006-2007	DoD facilities and infrastructure	$1.8 billion	15.1%	FY2005
	Army aviation and missiles	$1.6 billion	18.6%	FY2005
	Marine Corps ground vehicles	$0.7 billion	20.8%	FY2005
2007-2008	Navy and Marine Corps aviation	$3.0 billion	31.5%	FY2005 and FY2006
	Coast Guard aviation and vessels	$0.3 billion	25.5%	FY2005 and FY2006
2008-2009	Air Force aircraft and missiles	$5.4 billion	32.2%	FY2006 and FY2007
	Army ground vehicles	$2.4 billion	14.3%	FY2006 and FY2007
	Navy ships	$3.2 billion	26.3%	FY2006 and FY2007
	All other DoD segments	$5.1 billion	22.1%	FY2006
2009	Total DoD annual corrosion cost	$23.2 billion	23.0%	FY2006

Purpose

Provide methodology and results on the cost of corrosion studies for Army Aviation/Missile and Ground Vehicle equipment

Combined Top-down/Bottom-up Methodology

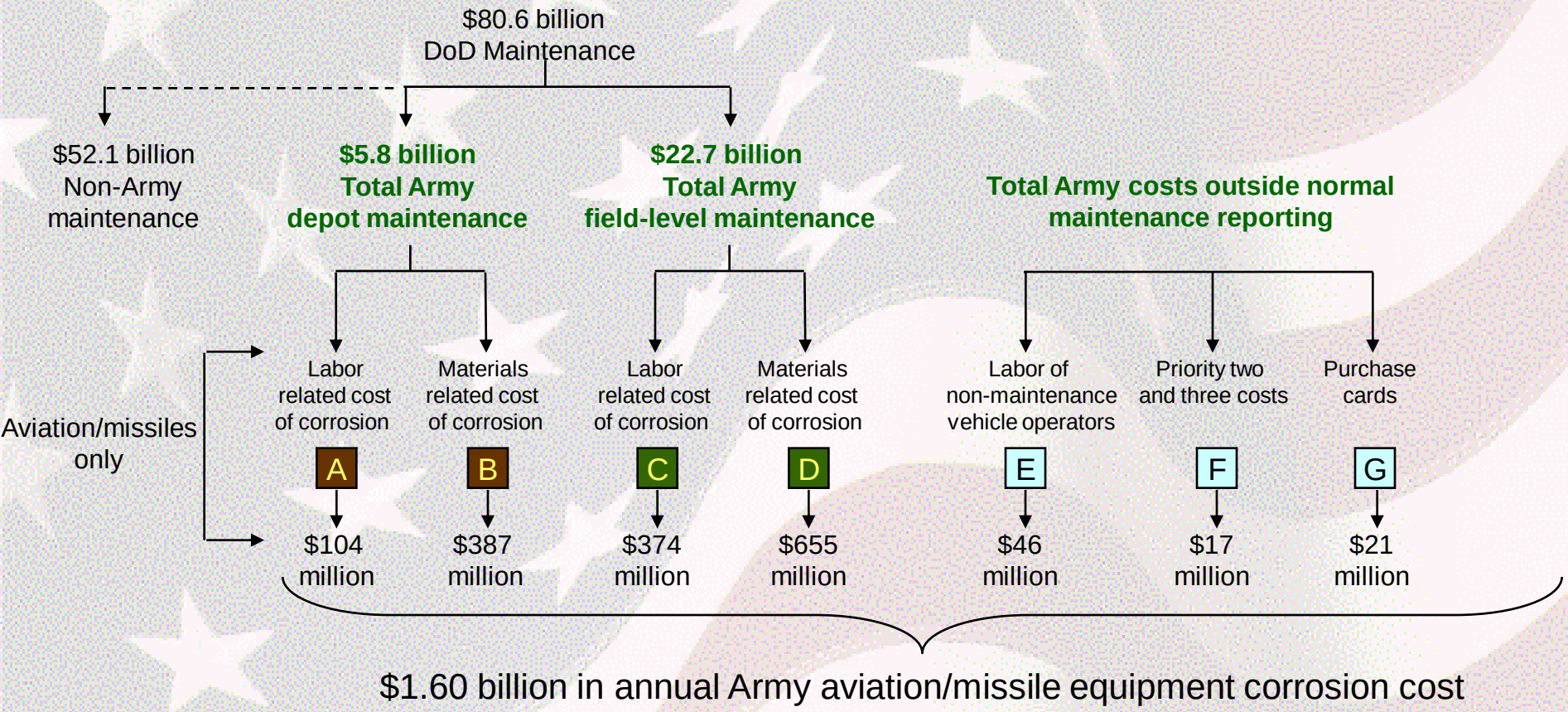
(Example—Determining Monthly Expenses for Meat)



Must use grocery and restaurant receipts to determine meat expenses

Top-Down Data Collection and Cost Tree

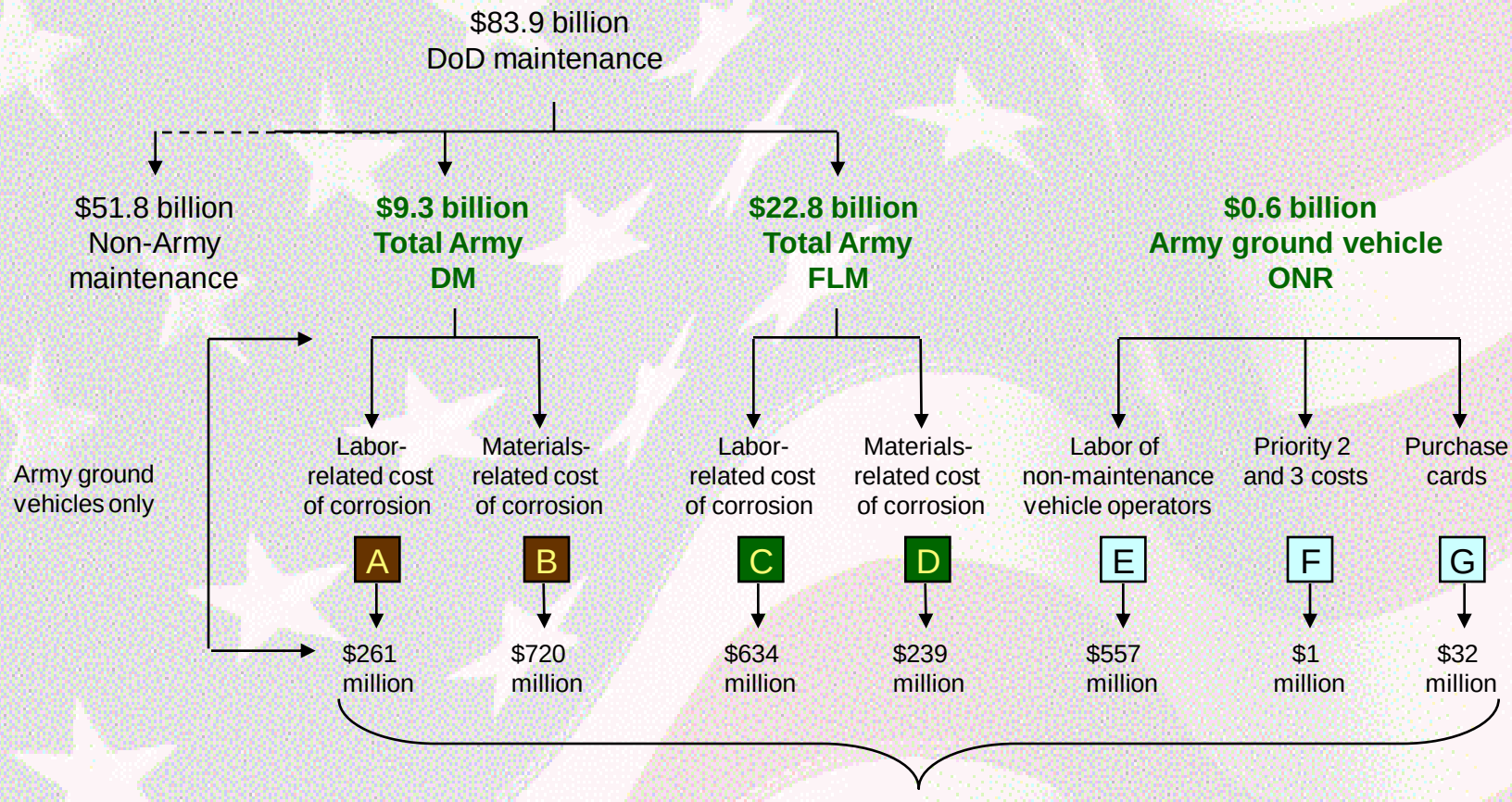
(Army Aviation/missiles example – FY2005)



$1.60 billion in annual Army aviation/missile equipment corrosion cost

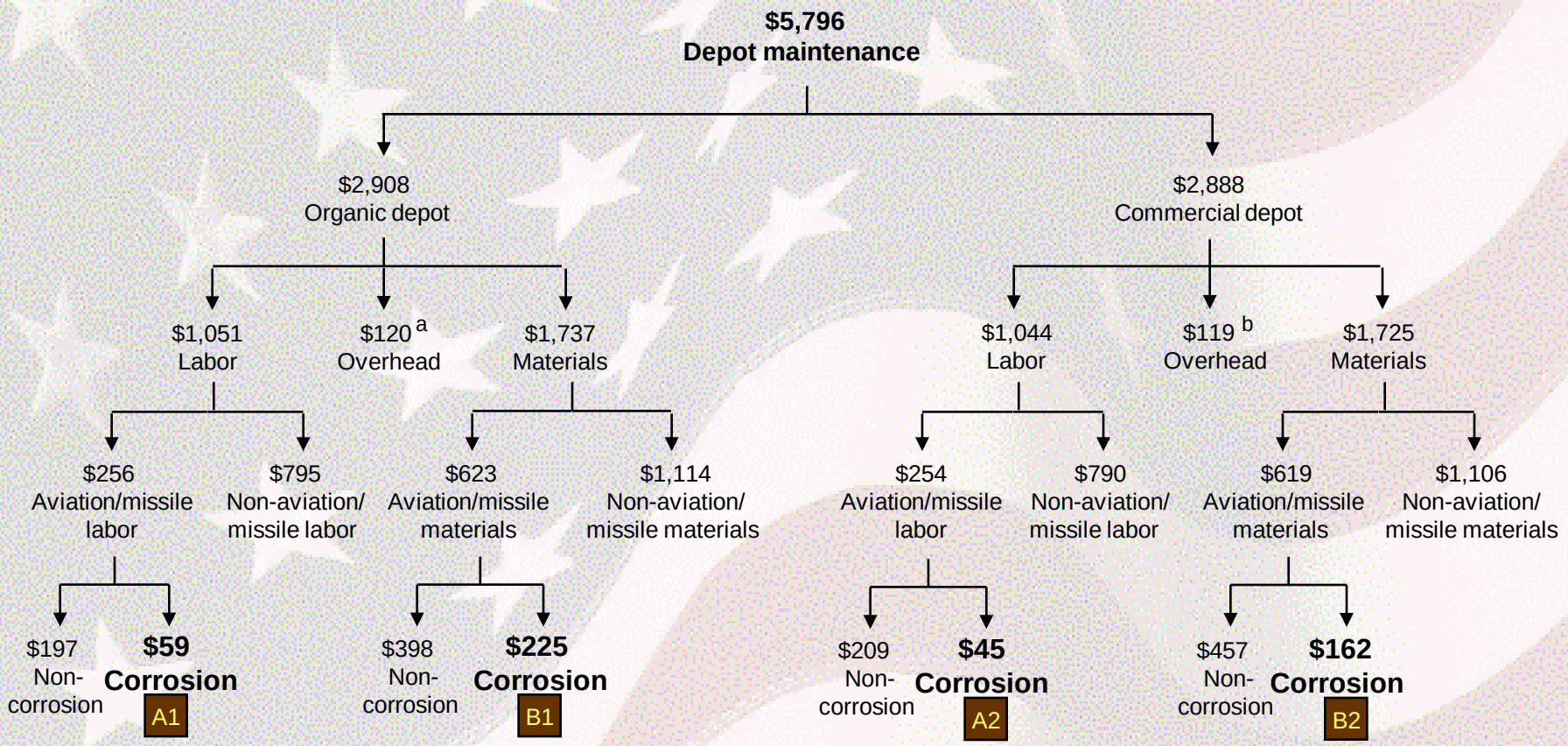
Top-Down Data Collection and Cost Tree

(Army Ground vehicle example – FY2007)



$2.4 billion estimated annual Army ground vehicle corrosion cost

Cost Tree—Depot Example
(Army Aviation/missiles example – FY2005)



Data Conversion—Army Aviation/Missiles

Main **Depot** Data Sources	Data Value	Main **Field-Level** Data Sources	Data Value	Main "**Outside Normal Reporting**" Data Sources	Data Value
Depot Expenses Report	Top-Down	DMDC	Top-Down	Survey	Top-Down
50-50 Reporting	Top-Down	ILAP	Bottom-Up	DMDC	Top-Down
DMDC	Top-Down	Haystack	Bottom-up	Purchase Card Records	Bottom-Up
OSMIS	Bottom-Up	OP-31 Exhibit	Top-Down	CPCIPT Projects	Bottom-Up
AMLCMC Commercial	Bottom-Up	LIDB	Bottom-Up		
JO/PCN Detail Report	Bottom-Up	OSMIS	Bottom-up		
Parts Analysis by PCN	Bottom-Up	AMDS	Bottom-up		
DMCS	Bottom-Up	ELAS	Bottom-up		

DMDC	=	Defense Manpower Data Center
OSMIS	=	Operating and Support Management Information System
AMLCMC	=	Aviation and Missile Lifecycle Management Command
PCN	=	Production Control Number
DMCS	=	Depot Maintenance Cost System
ILAP	=	Integrated Logistics Analysis Program
Haystack	=	DoD Material Demand Database
OP-31 Exhibit	=	Annual Budget Document
LIDB	=	Logistics Integrated Database
CPCIPT	=	Corrosion Prevention and Control Integrated Product Team

Data Conversion—Army Aviation/Missiles

Initial Data

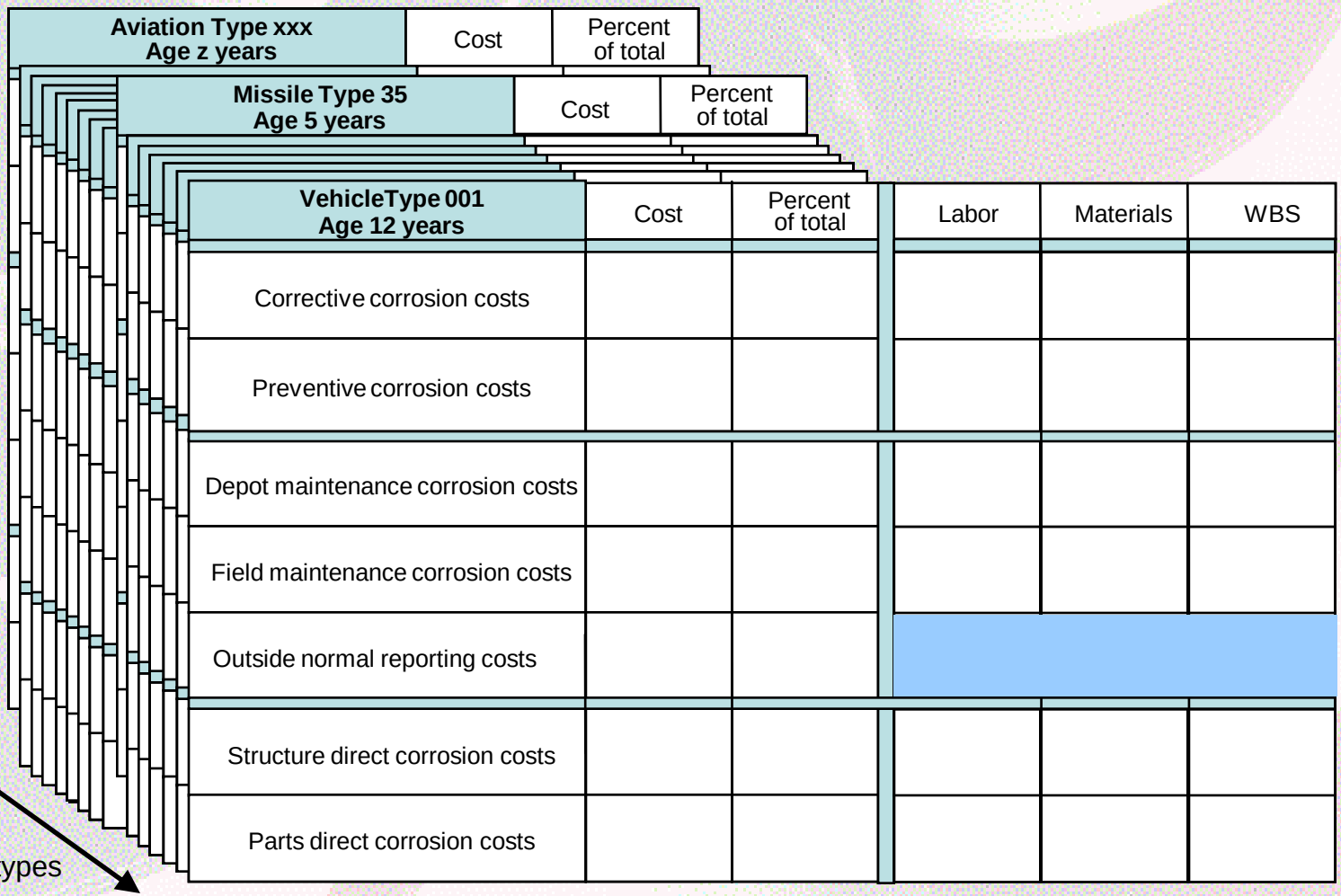
553C0	P01D2GA1GK2L3	00000700+00000004+REMOVE	BUSHING	SH	60	SH-6	
529B0	P07K6KA2BAAG1	00001200+00000004+REPR	GEARBOX	AH64	APACHE	EA	G
F4CA0	P03BBFA3HFQC2	00000200+00000004+TIP	CAP	TORQUE	&	GAP	CHK M/R
F4CA0	P02BBFB0HFQE1	00000800+00000004+TORQUE	TIP	BLOCK	UH60		
553F0	P01STHA3GAW31	00000200+00000004+WJSTRIP	CASE	401C	EA	C	
553F0	P01STHA3GAW41	00000200+00000004+WJSTRIP	SHROUD	401C	EA	S	
543B0	P01PS1C2HA121	00000200+00000005+A/FLOW	3RD	STGE	NOZZLE	NOZZ	

Scrubbed Data

Work Center	PCN	EIC	WAC	Op Code	Hr YTD	Prod YTD	Operation	Subcomponent	End Item
553C0	P01D2G	D2G	A1	GK2L	7	4	Remove Bushing	Bushing	SH 60
529B0	P07K6K	K6K	A2	BAAG	12	4	Repair Gearbox	Gear Box	AH 64D
F4CA0	P03BBF	BBF	A3	HFQC	2	4	Tip Cap Torque and gap	Main Rotor Blade	UH-60
F4CA0	P02BBF	BBF	B0	HFQE	8	4	Torque Tip Block	Main Rotor Blade	UH-60
553F0	P01PTA	PTA	C2	GAWS	2	4	Water jet Strip Coating	Case 401 C	401 C Engine
553F0	P01STH	STH	A3	GAW3	2	4	Water jet Strip Coating	Shroud 401C	401 C Engine
553F0	P01STH	STH	A3	GAW4	2	4	Adjust Flow 3rd Stage Nozzle		401 C Engine

Initial Corrosion Data Extract

Data Structure



Over 300 Types of Army Aviation/Missile equipment, over 1,000 types of ground vehicles.

Highest 20 Corrosion Cost by End Item
(Army Aviation/missiles – FY2005)

Rank	LIN	Aviation or Missile	General Nomenclature	Maintenance cost ($ millions)	Corrosion cost ($ millions)	Number of Aviation or Missile Assets	Corrosion Percentage
1	H30517	Aviation	HELICOPTER CARGO TRANSPORT: CH-47D	$1,782.2	$352.0	413	19.8%
2	K32293	Aviation	HELICOPTER UTILITY: UH-60A	$1,706.8	$335.3	903	19.6%
3	H32361	Aviation	HELICOPTER UTILITY: UH-60L	$1,630.6	$243.0	544	14.9%
4	H48918	Aviation	HELICOPTER ATTACK: AH-64D	$859.8	$171.4	429	19.9%
5	A21633	Aviation	HELICOPTER AERIAL SCOUT: OH-58D	$678.1	$127.2	357	18.8%
6	ENGT-700	Aviation	T-700 ENGINE	$170.8	$57.4	1831	33.6%
7	H31110	Aviation	HELICOPTER OBSERVATION: OH-58C	$123.5	$38.8	280	31.4%
8	H28647	Aviation	HELICOPTER ATTACK: AH-64A	$195.3	$37.0	235	19.0%
9	ENGT-701	Aviation	T-701 ENGINE	$92.9	$24.1	1831	26.0%
10	ENGT-701D	Aviation	T-701D ENGINE	$55.0	$21.4	1830	38.8%
11	H44644	Aviation	HELICOPTER ATTACK: TOW MISSLE AH-1F	$44.1	$17.4	71	39.4%
12	H31872	Aviation	HELICOPTER UTILITY: UH-1V	$43.5	$13.8	150	31.6%
13	L45740	Missile	LAUNCHER TUBULAR GUIDED MISSILE: (TOW)	$55.7	$10.8	2825	19.4%
14	ENGT-703	Aviation	T-703 ENGINE	$30.4	$9.7	786	31.9%
15	K31795	Aviation	HELICOPTER UTILITY: UH-1H	$26.9	$9.3	273	34.6%
16	P11779	Missile	PATRIOT: PAC-3 LAUNCHER STATION	$150.3	$8.2	31	5.4%
17	H46150	Aviation	HELICOPTER CARGO: MH-47E	$24.1	$7.8	23	32.5%
18	ENGT-701C	Aviation	T-701C ENGINE	$19.9	$7.5	1830	37.7%
19	ENGT-63	Aviation	T-63 ENGINE	$21.4	$6.8	986	31.9%
20	L44830	Missile	LAUNCHER: GUIDED MISSILE AIRCRAFT	$41.9	$6.4	2093	15.3%

Highest 20 Average Corrosion Cost

(Army Aviation/missiles – FY2005)

Rank	LIN	Aviation or Missile	General Nomenclature	Number of Aviation or Missile Assets	Corrosion cost ($ thousands)	Average corrosion cost per Item ($ thousands)
1	H30517	Aviation	HELICOPTER CARGO TRANSPORT: CH-47D	413	$352,009	$852
2	H32361	Aviation	HELICOPTER UTILITY: UH-60L	544	$243,037	$447
3	H48918	Aviation	HELICOPTER ATTACK: AH-64D	429	$171,449	$400
4	K32293	Aviation	HELICOPTER UTILITY: UH-60A	903	$335,336	$371
5	A21633	Aviation	HELICOPTER AERIAL SCOUT: OH-58D	357	$127,199	$356
6	H46150	Aviation	HELICOPTER CARGO: MH-47E	23	$7,822	$340
7	P11779	Missile	PATRIOT: PAC-3 LAUNCHER STATION	31	$8,169	$264
8	H44644	Aviation	HELICOPTER ATTACK: TOW MISSLE AH-1F	71	$17,400	$245
9	U84291	Aviation	HELICOPTER MEDEVAC: HH-60L	18	$4,214	$234
10	H30766	Aviation	HELICOPTER CARGO: MH-60K	23	$4,673	$203
11	H28647	Aviation	HELICOPTER ATTACK: AH-64A	235	$37,025	$158
12	H31110	Aviation	HELICOPTER OBSERVATION: OH-58C	280	$38,767	$138
13	H31872	Aviation	HELICOPTER UTILITY: UH-1V	150	$13,778	$92
14	Z52435	Aviation	RADAR SET: AN/TPN-18	15	$1,053	$70
15	Q18667	Aviation	RADAR SYSTEM: AN/FSQ-84	21	$914	$44
16	Q14455	Aviation	RADAR SET: AN/FPN-40	18	$662	$37
17	K31795	Aviation	HELICOPTER UTILITY: UH-1H	273	$9,318	$34
18	ENGT-700	Aviation	T-700 ENGINE	1831	$57,385	$31
19	G93247	Missile	GROUND SUPPORT EQUIPMENT: DS/GS (GLLD)	54	$1,663	$31
20	W00221	Aviation	TEST STAND HYDRAULIC SYSTEM COMPONENTS: GAS ENG DRIVEN	79	$2,059	$26

Highest 20 Combined Corrosion Cost

(Army Aviation/missiles – FY2005)

Number	LIN	Nomenclature	Corrosion cost per item ($ thousand)	Corrosion Cost ($ thousand)	Rank in highest 20 corrosion cost per item	Rank in highest 20 total corrosion cost	Combined rank
1	H30517	Helicopter cargo transport - CH47D	$852	$352,009	1	1	2
2	H32361	Helicopter utility - UH-60L	$447	$243,037	2	3	5
3	K32293	Helicopter utility - UH-60A	$371	$335,336	4	2	6
4	H48918	Helicopter attack - AH-64D	$400	$171,449	3	4	7
5	A21633	Helicopter scout - OH-58D	$356	$127,199	5	5	10
6	H31110	Helicopter observation - OH-58C	$138	$38,767	12	7	19
7	H28647	Helicopter advanced attack - AH-64A	$158	$37,025	11	8	19
8	H44644	Helicopter attack - AH-1F	$245	$17,400	8	11	19
9	P11779	Patriot - PAC3 launching station	$264	$8,169	7	16	23
10	H46150	Helicopter cargo - MH-47E	$340	$7,822	6	17	23
11	ENGT-700	Engine - T700	$31	$57,385	18	6	24
12	H31872	Helicopter utility - UH-1V	$92	$13,778	13	12	25
13	K31795	Helicopter utility - UH-1H	$34	$9,318	17	15	32

Corrosion Cost by WBS

(Army Aviation/missiles – FY2005)

WBS	Description	Corrosion cost ($ thousands)	Total maintenance cost ($ thousands)	Rank
A91	Helicopter (Frames)	$954.1	$3,146.7	1
A92	Helicopter Engine	$171.0	$549.9	2
A94	Helicopter Electronics and Communications Equipment	$80.8	$322.7	3
A95	Helicopter Armament	$36.8	$165.5	4
F21	Other Missile Basic Missiles (Frames)	$22.8	$98.2	5
A96	Helicopter Support Equipment	$15.8	$50.0	6
B11	Tactical Vehicle Frame (Missile)	$5.5	$75.9	7
F26	Other Missiles Surface Communication and Controls Systems	$3.6	$25.4	8
F24	Other Missiles Support and Launch Equipment	$3.2	$33.7	9
F11	Ballistic Basic Missiles (Frame)	$2.9	$10.4	10
B15	Tactical Vehical Armament (Missiles)	$1.8	$34.7	11
A97	Helicopter Other	$1.8	$7.0	12
B14	Tactical Vehicle Electronics and Communications (Missiles)	$1.8	$31.1	13
F15	Ballistic Missiles Guidance System and Components	$1.6	$6.1	14
B16	Tactical Vehicle Support Equipment (Missiles)	$1.0	$17.8	15
F25	Other Missiles Guidance System and Components	$0.6	$3.4	16
F28	Other Missiles Other	$0.6	$248.8	17
A31	Cargo and/or Transport Aircraft Frame	$0.6	$1.8	18
F14	Ballistic Missiles Support and Launch Equipment	$0.6	$2.2	19
B12	Tactical Vehical Engines (Missiles)	$0.2	$4.7	20
UNASSIGNED		$258.6	$3,420.9	-

Corrective versus Preventive Corrosion Cost
(Army Aviation/missiles – FY2005)

	Category	Corrosion cost (in millions)	Percentage of total maintenance cost
Depot-level maintenance	Corrective	$252	51.3%
	Preventive	$240	48.7%
	Total	$492	100%
Field-level maintenance	Corrective	$766	74.5%
	Preventive	$263	25.6%
	Total	$1,028	100%
Total maintenance	Corrective	$1,018	66.9%
	Preventive	$503	33.1%
	Total	$1,521	100%

Parts versus Structure Corrosion Cost
(Army Aviation/missiles – FY2005)

	Cost category	Total maintenance cost (in millions)	Corrosion cost (in millions)	Corrosion as percentage of total maintenance cost
Depot-level maintenance	Structure	$576	$126	21.9%
	Parts	$1,177	$365	31.0%
Field-level maintenance	Structure	$5,012	$839	16.7%
	Parts	$1,363	$190	13.9%
Total maintenance	Structure	$5,588	$965	17.3%
	Parts	$2,540	$555	21.8%
Total		$8,128	$1,520	18.7%

Highest 20 Corrosion Cost by End Item

(Army Ground vehicles – FY2007)

Rank	LIN	Nomenclature	Total maintenance cost (in millions)	Total corrosion cost (in millions)	Corrosion as a percent of maintenance
1	T61494	Truck utility: cargo	$1,130	$154	13.6%
2	T13305	Tank combat 120MM M1A2	$415	$100	24.1%
3	T07679	Truck utility: heavy	$403	$99	24.6%
4	R50681	Recovery vehicle M88A1	$362	$89	24.6%
5	T13168	Tank combat 120MM M1AI	$440	$85	19.3%
6	X40009	Truck cargo: 2 1/2 ton	$328	$60	18.3%
7	T92242	Truck utility: ARMT CA	$356	$57	16.0%
8	R50885	Recovery vehicle M88A2	$162	$48	29.6%
9	X40794	Truck cargo: drop side	$318	$45	14.2%
10	H57642	Howitzer medium M109A6	$175	$36	20.6%
11	X59326	Truck tractor: 5 ton 6	$235	$31	13.2%
12	X40146	Truck cargo: 2 1/2 ton	$129	$27	20.9%
13	X63299	Truck wrecker M936A2	$144	$27	18.8%
14	T92446	Truck utility HMMWV M1114	$334	$25	7.5%
15	J81750	Infantry fighting vehicle M2	$217	$24	11.1%
16	X50436	Truck lift EFG2/6002	$93	$23	24.7%
17	T61103	Truck tractor M915A3	$144	$21	14.6%
18	T60081	Truck cargo: 4×4 LMTV	$174	$20	11.5%
19	R18701	Radar set mounted	$68	$19	27.9%
20	T63093	Truck wrecker M984A1	$109	$19	17.4%
A[a]	Unknown		$573	$115	20.1%
B[a]	Engine		$605	$113	18.7%
C[a]	Transmission		$153	$21	13.7%

Highest 20 Average Corrosion Cost
(Army Ground vehicles – FY2007)

Rank	LIN	Nomenclature	Average corrosion cost per vehicle	Number of vehicles	Total maintenance cost (in millions)	Total corrosion cost (in millions)
1	R18701	Radar set mounted	$456,000	41	$68	$19
2	R50885	Recovery vehicle M88A2	$325,000	146	$162	$48
3	P60658	Carrier personnel	$167,000	95	$61	$16
4	X50436	Truck lift EFG2/6002	$129,000	178	$93	$23
5	R18815	Radar set mounted	$103,000	37	$17	$4
6	**T13305**	**Tank combat 120MM M1A2**	**$84,000**	**1,196**	**$415**	**$100**
7	R66273	Refuel system HEMTT	$66,000	275	$55	$18
8	R50681	Recovery vehicle M88A1	$42,000	2,138	$362	$89
9	T07814	Truck CR with ITAS M1121P1	$39,000	121	$11	$5
10	H57642	Howitzer medium M109A6	$37,000	980	$175	$36
11	J97621	Light armored vehicle M1132	$36,000	54	$40	$2
12	S72846	Semi-trailer fuel M131A5	$22,000	31	$2	$1
13	X63573	Truck wrecker 6×4 34500	$22,000	17	$0	$0
14	J81750	Infantry fighting vehicle M2	$22,000	1,101	$217	$24
15	**T13168**	**Tank combat 120MM M1A1**	**$19,000**	**4,490**	**$440**	**$85**
16	**A80593**	**Antenna OE-349/MRC**	**$17,000**	**121**	**$10**	**$2**
17	R16611	RO TE CH KALMAR RT240	$16,000	345	$36	$6
18	T10549	S/EQ S/WEST SGPRSMD	$15,000	73	$8	$1
19	X43845	Truck dump 5 ton W/W M817	$15,000	396	$18	$6
20	T39518	Truck cargo tactical W/W	$15,000	485	$29	$7

Highest 20 Combined Corrosion Cost

(Army Ground vehicles – FY2007)

LIN	Description	Average corrosion cost per vehicle	Rank in top 20: corrosion cost per vehicle	Total corrosion cost	Rank in top 20: total corrosion cost	Total (rounded) corrosion cost
T13305	Tank combat 120MM M1A2	$84,000	6	$100	2	$100
R50885	Recovery vehicle M88A2	$325,000	2	$48	8	$48
R50681	Recovery vehicle M88A1	$42,000	8	$89	4	$89
T13168	Tank combat 120MM M1A1	$19,000	15	$85	5	$85
H57642	Howitzer medium M109A6	$37,000	10	$36	10	$36
X50436	Truck lift EFG2/6002	$129,000	4	$23	16	$23
R18701	Radar set mounted	$456,000	1	$19	19	$19
J81750	Infantry fighting vehicle M2	$22,000	14	$24	15	$24

Corrosion Cost by WBS
(Army Ground vehicles – FY2007)

WBS	Description	Maintenance cost (in millions)	Corrosion cost (in millions)	Corrosion as a percent of maintenance
B13	Tactical vehicle and engine components and accessories	$2,990	$374	12.5%
B11	Tactical basic vehicle (hull and/or body frame and installed systems)	$655	$188	28.7%
B23	Support vehicle and engine components and accessories	$870	$130	14.9%
B10	Tactical vehicles	$1,122	$104	9.3%
C41	Other combat vehicle basic vehicle (hull and/or body frame and installed systems)	$235	$83	35.2%
C13	Tanks vehicle and engine components and accessories	$378	$76	20.1%
ENG	Unknown vehicle type engine	$380	$71	18.7%
C11	Tanks basic vehicle (hull and/or body frame and installed systems)	$185	$70	37.7%
B12	Tactical vehicle engine	$521	$70	13.4%
C12	Tank engine	$365	$65	17.9%
B21	Support vehicle basic vehicle (hull and/or body frame and installed systems)	$136	$64	47.1%
B20	Support vehicles	$819	$51	6.2%
D13	Tractors and earth moving equipment vehicle and engine components and accessories	$332	$46	13.9%
E2	Radar	$143	$40	28.0%
B17	Tactical vehicles other	$177	$38	21.6%
C31	Self-propelled artillery basic vehicle (hull and/or body frame and installed systems)	$126	$34	27.2%
C23	Armored personnel carriers vehicle and engine components and accessories	$543	$32	5.9%
C21	Armored personnel carriers basic vehicle (hull and/or body frame and installed systems)	$113	$27	24.0%
C43	Other combat vehicle and engine components and accessories	$120	$23	19.2%
UNK7	Unknown vehicle type others	$174	$21	11.8%

Corrective versus Preventive Corrosion Cost (Army Ground vehicles – FY2007)

	Category	Corrosion cost ($ in millions)	Corrosion as a percent of maintenance
Depot-level maintenance	Corrective	$314	32.1%
	Preventive	$666	67.9%
	Total	$980	100.0%
Field-level maintenance	Corrective	$653	74.8%
	Preventive	$221	25.2%
	Total	$874	100.0%
Total maintenance	Corrective	$968	52.2%
	Preventive	$886	47.8%
	Total	$1,854	100.0%

Parts versus Structure Corrosion Cost
(Army Ground vehicles – FY2007)

	Cost category	Total maintenance cost (in millions)	Corrosion cost ($ in millions)	Corrosion as a percentage of total maintenance costs
Depot-level maintenance	Structure	$1,344	$516	38.4%
	Parts	$2,309	$463	20.1%
Field-level maintenance	Structure	$2,926	$241	8.2%
	Parts	$5,973	$633	10.6%
Total maintenance	Structure	$4,271	$757	17.7%
	Parts	$8,282	$1,097	13.2%